

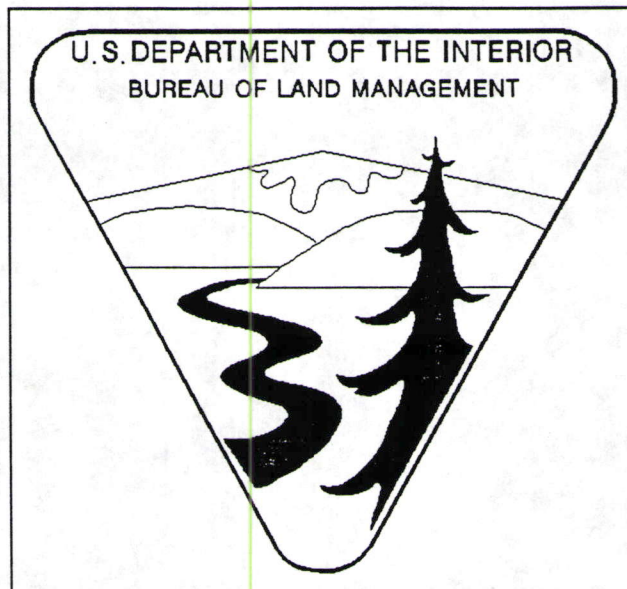
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WHITE RIVER OIL SHALE

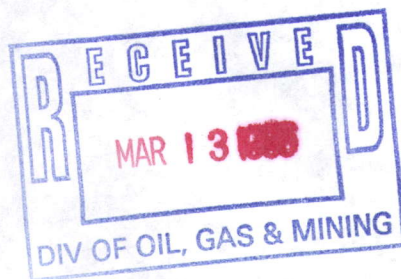
MINE CLOSURE

DOGM
MINERALS PROGRAM
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Vernal District
Bureau of Land Management



81 201



Executive Summary:

In February 1983 the White River Oil Shale project commenced. In September 1986 in connection with the State of Utah, The Bureau of Land Management (BLM) accepted this property with a reclamation fund. BLM has decided to close the White River Oil Shale (WROS) mine with its associated structures. The property site location is approximately 10 miles from Bonanza, Utah (See Fig. 1). The mine currently consists of essentially 3 vertical shafts and 3 declines. One shaft and one decline intercept the regionally defined Birds Nest aquifer. This aquifer was grouted both in the shaft and in the decline during mining to restrict the flow of water into the mine. The bottom of the decline penetrates a Tuff zone that produces a small amount of heavy paraffinic crude oil products.

This proposal is to place a bulkhead below the bottom of the Birds Nest aquifer along with the existing grout zone to keep the water containing the heavy paraffinic crude oil products isolated from the aquifer in the decline. The shaft liner and the grout zone will protect the Birds Nest aquifer in the shaft. The surface will be protected by sealing all 3 shafts with approximately 2 feet of concrete and fill the portal. This will environmentally and economically seal the White River Oil Shale mine while adequately protecting the Birds Nest aquifer.

B. Production Declines.

1. Decline A.

Size: 28.5 ft. wide by 12.75 ft. high by 2074 ft. Long.

Slope Grade: 23.75 %

Construction: Paurat Roadheader E 182

Ground Support: Rock Bolts on 5 foot centers in the roof (back) and 2 ft. centers along the rib. Bolts are 1 inch in diameter reinforcing steel, 8 ft. long with resin encapsulation.

Date Decline Started: 27 Oct. 1982

Date Decline intercepts the Fresh Air Shaft: 12 July 1984

Date Declines were Completed: 20 Sept. 1984

Portal Coordinates: N 590,158.95
E 2,645,701.43

Portal Elevation: 5398.00

2. Decline B.

Size: 18.5 ft. wide by 12.75 ft. high by 330 ft. long.

Slope Grade: None

Construction: Conventional mining methods.

Ground Support:

This acts as a travel way between Declines A and C.

3. Decline C.

Size: 18.5 ft. wide by 12.75 ft high by 2500 ft. long.

Construction: See Decline A.

Ground Support: See Decline A.

Birds Nest zone: Initial flows from the zone were from 60 to 360 gallons per minute (gpm).

Grout zone: Grout zone started at approximately 4890 and ended at approximately 4740. Grouting with Terraseal reduced that flow to a current 1 gpm. Slope distance of the grout cover is 450 ft.

Other Water Inflow: Two (2) zones in the Unita Sandstone formation are making water at a maximum of 0.5 gpm.

C. Other Workings.

1. Test Room.

Size: 55 ft wide by 10 ft high by 330 ft long

Access Drift Size: 10 ft. wide by 10 ft high by 500 ft long.

Access Ramp Size: 10 ft. wide by 10 ft high by 60 ft long.

100 feet of the Test Room roof is unsupported.

2. Hoist Station.

Size: 50 ft. wide by 60 ft high by 400 ft. long.

3. Crusher Chamber.

Size: 60 ft wide by 50 ft. high by 400 ft long.

Oil Seep is making 0.5 barrels per month.

Minor Water Seep is present.

4. East Drift.
Size: 28.5 ft. wide by 12.75 ft high by 800 ft.
long.
5. South Access Ramp.
Size: 18 ft. wide by 12.75 ft. high by 800 ft.
long.
6. Water Sump.
7. Ore Pass.
8. Conveyer Transfer Station.
9. Water Wells.
Number: 2
Depth: 50
Diameter: 8 inches approximately
Each contains a 4 inch submersible pump.

Geology: The formations in ascending order are as follows:(See Fig's 3 & 4):

- Unita formation
- Green River formation
 - Birds Nest zone (aquifer)
- Parachute member
- Garden Gulch member
 - Douglas Creek aquifer
- Douglas Creek member
- Wasatch formation

The Wasatch formation forms the bottom of the Unita Basin.

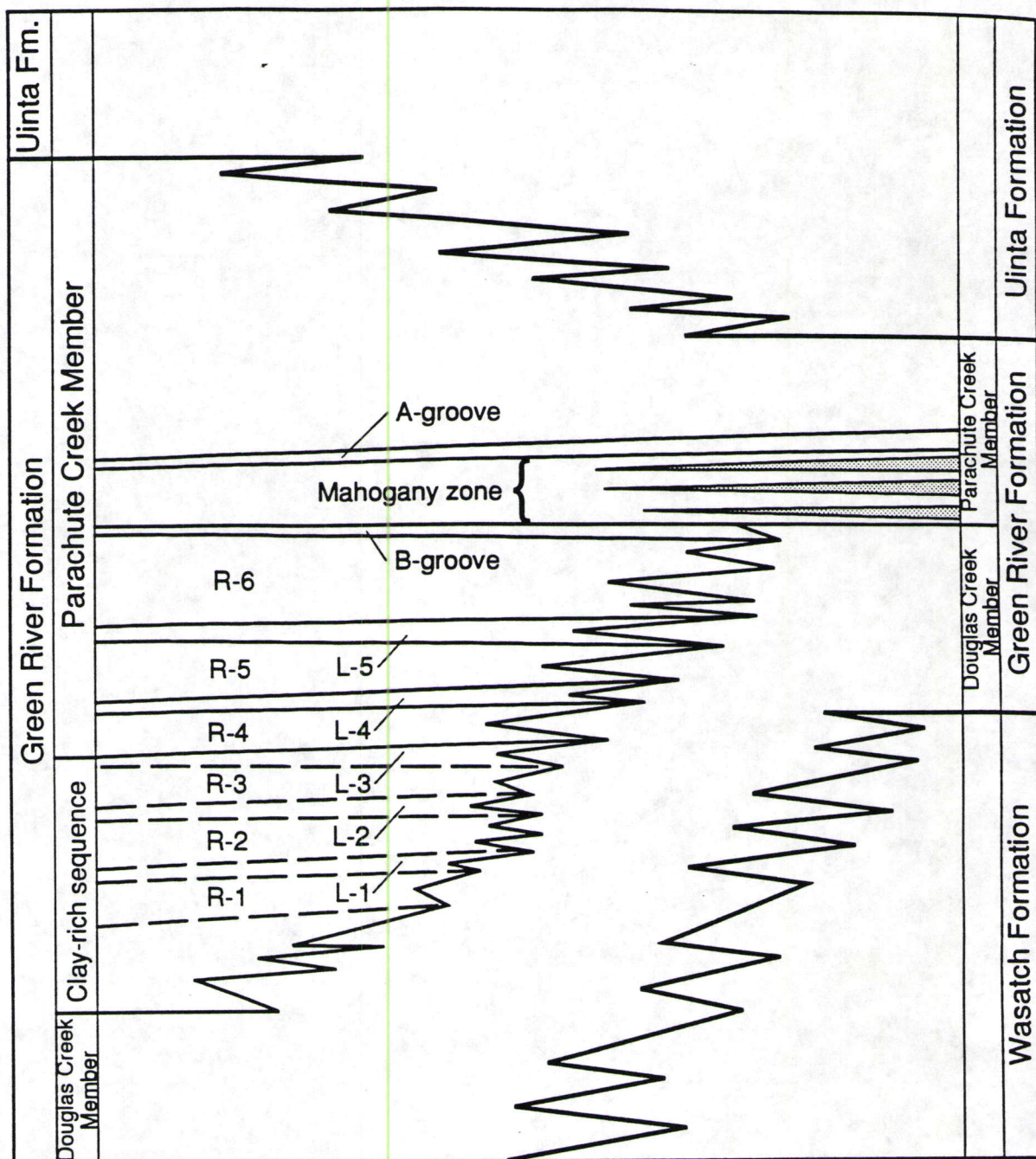
The Green River formation basal geologic member is the Douglas Creek member. It is composed mainly of sandstone, siltstone, shale and oolitic, algal, and ostracodal limestones. It contains very few oil-shale beds. In the area in question it has a range of 850 to 900 feet thick. (T10S R 25E). The Douglas Creek aquifer lies in the Douglas Creek formation that is below the Mahogany zone. Because there is no interception of this zone it is of no concern to the closure process.

Overlying the Douglas Creek member is the Garden Gulch member that is possibly the same as the Clay-rich sequence. This member is primarily composed of marlstone. The marlstone has appreciable amounts of organic matter, oil shale and siltstone. It is characterized by thin and even-bedded gray and brown marlstone. It has less oil than the Douglas Creek member.

The Parachute Creek member that lies over the Garden Gulch member, is composed mainly of marlstone, oil shale and Tuff. It is this main member that contains the Mahogany zone. The Mahogany zone comprises of uniform and thin kerogen beds which are of the greatest economic interest. The kerogen beds in this area are uniform and thin. This zone ranges from 2 to 60 feet thick. The Mahogany Marker is a Tuff bed that is 9-20 feet above the Mahogany zone. This bed is approximately 0.3 to 0.6 feet thick and is continuous throughout the region and is the richest zone containing kerogen in the area. There is a Tuff bed that lies directly below

Lake-Center Sequence

Lake-Margin Sequence



DEPTH IN FEET BELOW GROUND SURFACE

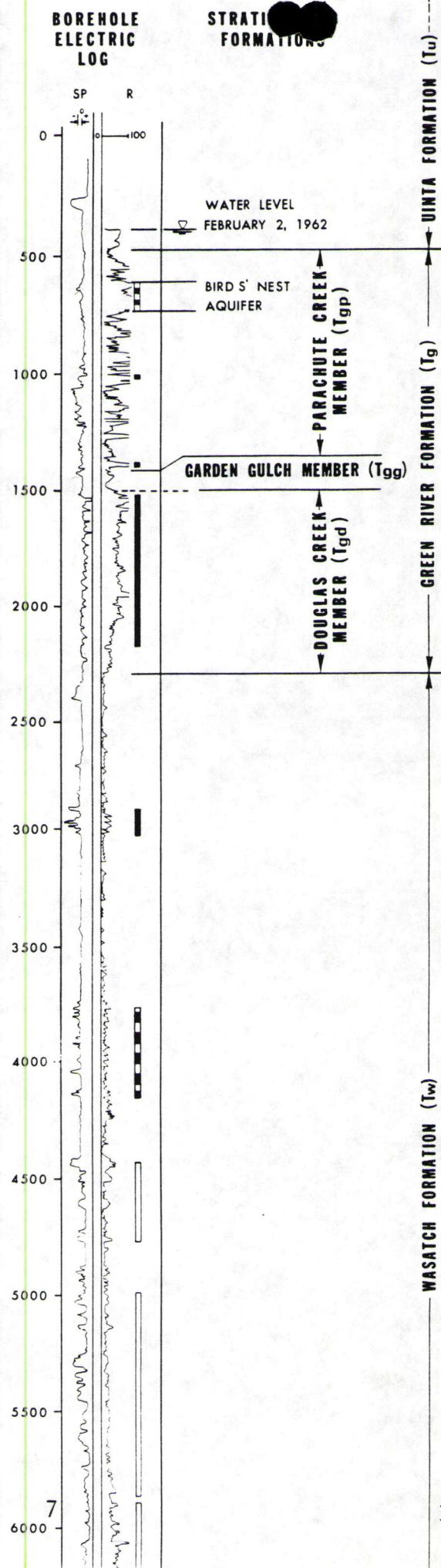


Fig. 4

the Mahogany zone that seeps heavy paraffinic crude oil products into the mine. (The oils seep rate is estimated at 0.5 barrels per month.) Another Tuff bed that lies approximately 55-85 feet above the Mahogany Marker. This bed is distinctive because it contains thin intercalated stringers of marlstone.

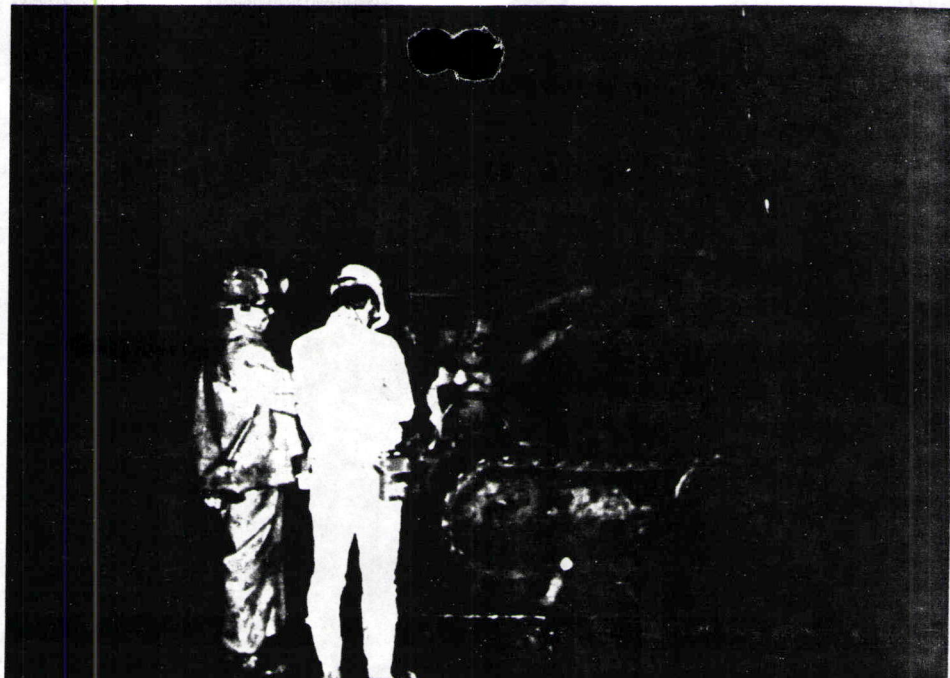
The Birds Nest zone (aquifer) lies in the upper portion of the Parachute Creek member (BLM, 1984). This marlstone and siltstone zone lies from 50 to 125 feet below the top of the Green River formation where the Birds Nest zone contacts the alluvium and the recharge potential is the greatest. This zone contains elliposoidal cavities that are 6 to 24 inches long in their longest dimension. The zone originally contained nacholite (soluble sodium bicarbonate mineral) which in some cases leached out. In some instances the nacholite has been replaced by calcium. These cavities are in a zone that is approximately 50 feet wide. The water appears to flow in these cavities or vugs. The aquifer is apparently under equilibrium conditions because input equals output. Electric well log data suggest that throughout the region the water-bearing zones of the Mesa Verde, Wasatch, and Green River formations appear to be well-isolated from one another by shales. There is a volcanic Tuff zone that lies above the Birds Nest zone.

The Unita formation overlies the Green River formation. It is typically divided into 3 zones. The 3 zones comprise the following; horizon A, 800 feet of hard sandstone with clay stone; horizon B, 350 feet of coarse sandstone; and horizon C, 600 feet of sandstones and claystones. There are some minor aquifers in the Unita formation. The water tends to be of lower TDS in the Unita formation. There are isolated conditions of water having TDS levels in excess on 81,000 (VTN). This appears to be the situation with the White River Oil Shale mine.

Birds Nest aquifer (zone) protection in the mine:
The Birds nest aquifer has a slope distance in decline "C" of the mine of about 450 feet (See Fig.5). Because the level of the water table of the Birds Nest aquifer was 12 feet higher than expected when the decline was driven, ring grouting was accomplished for the first interval of the decline. The White River Oil Shale Project Final Report, p. 22 states, "... work in the shaft indicated that grout movements of 65 ft plus could be expected." 3 grout covers were made (See Fig.6). Water flow in the Birds Nest aquifer while driving the decline ranged among 60 and 360 gpm per hole depending upon the location in the formation (See Fig. 7). The results of grouting now show the entire aquifer in the decline making about 2.5 gpm. The total material used in the decline grout cover was 2000 bags of cement, 403,246 lbs. of chemical grout (Terraseal 55 by Celtite Inc. of Georgetown, Kentucky), and 358,000 lbs. of limestone dust (See Fig. 7). This equates to approximately 1 ton of material per foot of drift. The decline was then shotcreted with type V cement with Seika Sigunit as an additive. Poor quality shotcrete was taken down during the operation and replaced. Most of the problems were encountered when the operators tried to hang a thick of a layer of shotcrete on the

G-9

Shaft air track
drill.



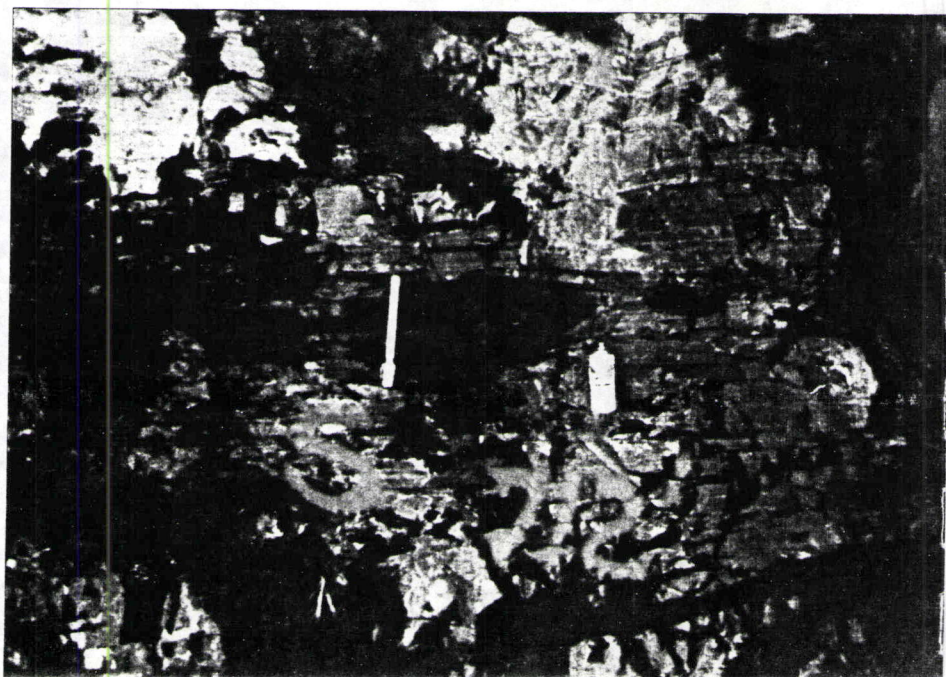
G-10

Vug at elevation 712
in shaft bottom.



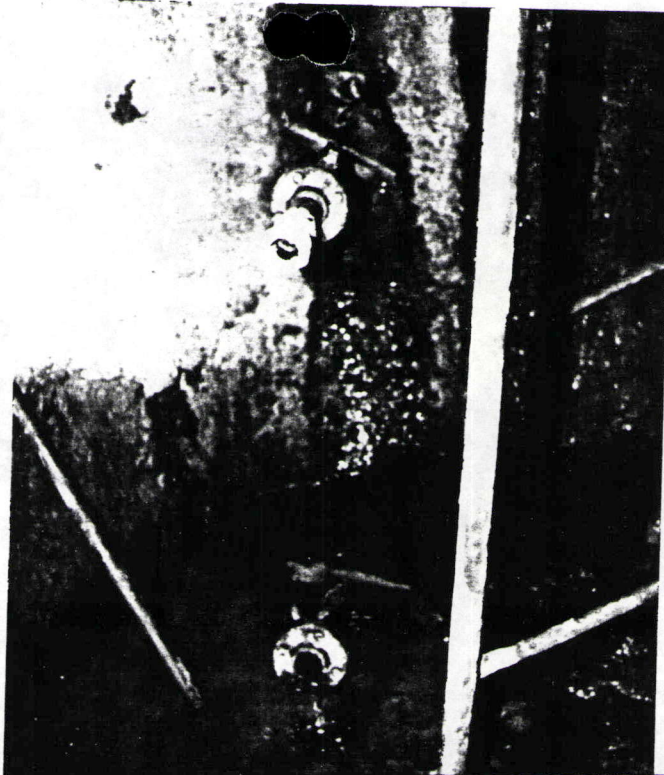
G-11

Horizontal banding of
marlstone at 712 feet.
Large vug on south wall.



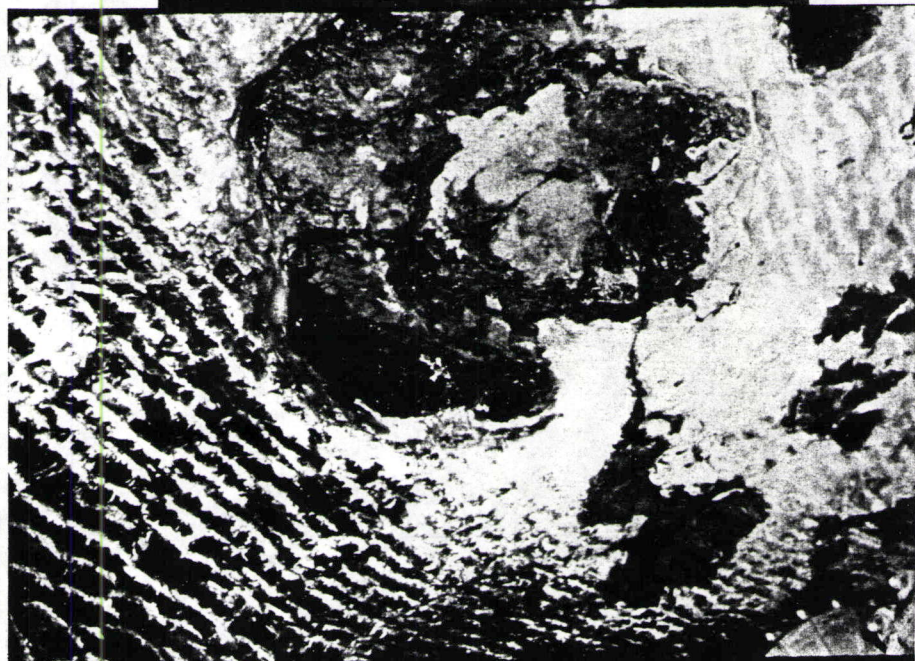
G-4

Stand pipe with full
flow ball valves.



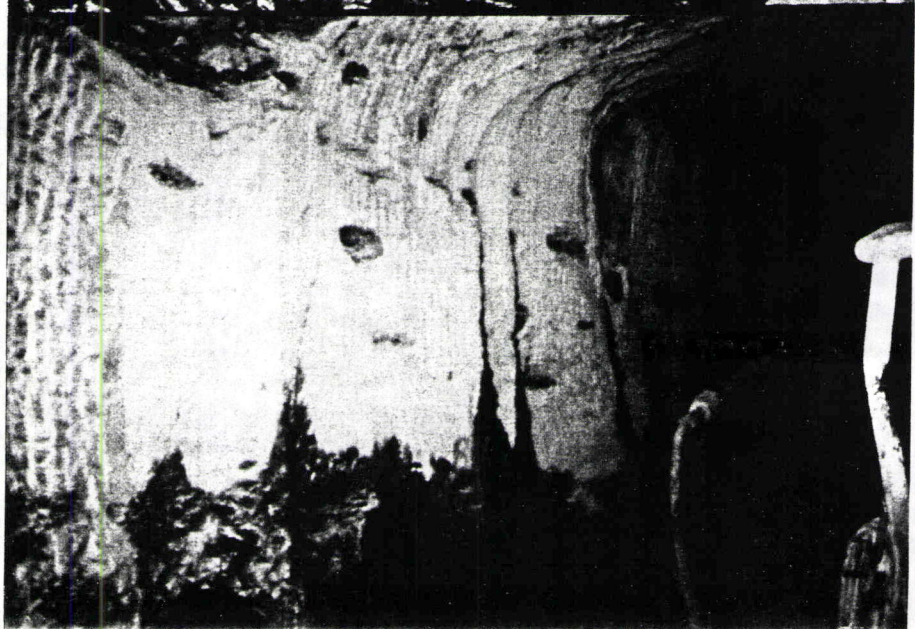
G-5

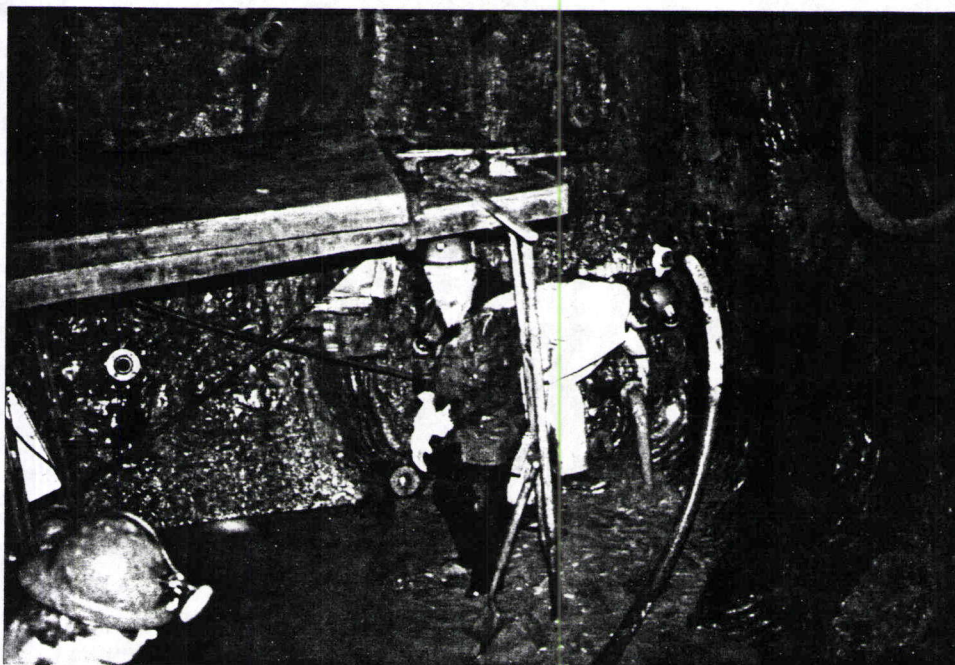
Vug filled with chemical
grout.



G-6

View of decline wall showing
band of vugs.

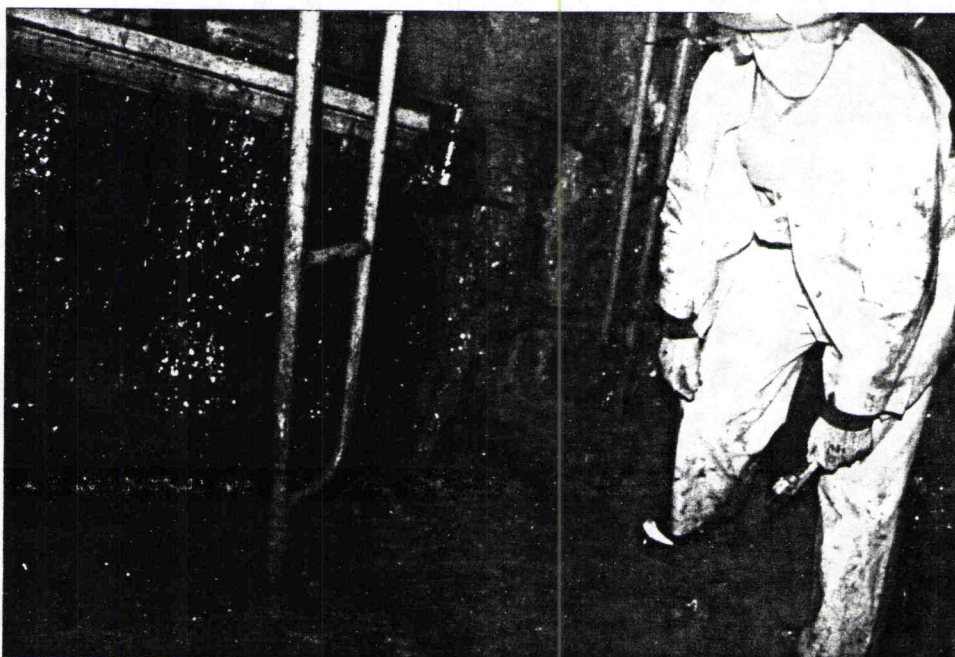




G-7

Water make from drill ho
3rd grout cover.

Estimated 80 GPM.



G-8

Water make from drill ho
3rd grout cover.

Estimated 65 GPM.

ribs and back. This would cause the material to "fall out". The Shaft was also grouted 110 feet before installing the cement lining. Two (2) grout covers totaling 293,880 lbs. of cement and 101,510 lbs. of chemical grout were made in the shaft. This equates to approximately 1.8 tons of material per foot of shaft. The estimated inflow of water in the shaft after grouting was estimated at 0.5 gpm. The shaft was concrete lined to a thickness of 20 inches in the Birds Nest aquifer zone. The slump was 4 inches and the minimum strength was 3000 psi. after a 28 day cure time.

Birds Nest Water Quality in the mine taken 10 Jan. 1984, Aug. 1994, Versus Unita formation from well P-2U and water dripping at the base of the 16' diameter ventilation bore hole intercepting Decline "A".

Parameters	BN 10 Jan 1984 mine	BN 1994 mine	Unita frm Mean P2U '75- 76	Unita frm Mean P2U 1984	Unita frm 1994 *	Unita frm 16' BH cross with Decline "A" 1994
Alkalinity Tot (mg/l)	1060	1082	497	722	NA	1345
Dissolved Solids (mg/l)	2745	2272	2444	1570	NA	11862
Hardness Tot (mg/l)	120	65.5	252	151	NA	2527.8
Non-Carbonate Hrdns (mg/l)	NA		0	0	NA	
Oil & Greas (mg/l)	NA		2	18	NA	
pH, field	8.6	8.9	8.2	9.3	NA	7.7
Specific Cond. (umhos)	4180	3450	3015	2370	NA	12350
Temperature (C)	NA	16	15.5	13.5	NA	16.5
Turbidity (NTU)	76	.35			NA	1.1
Ca, Dis (mg/l)	NA	4.8		21	NA	370

Parameters	BN 10 Jan 1984 mine	BN 1994 mine	Unita Frm Mean P2U Well 1975- 1976	Unita Frm Mean P2U Well 1984	Unita Frm 1994	Unita Frm 16' BH cross with Decline "A" 1994
Mg (mg/l)	20.1 6	13	44	24	NA	390
K (mg/l)	5.3	2	3.4	1.5	NA	4.7
Na, Dis (mg/l)	1000	790	737	524	NA	2900
SAR	NA		20	19	NA	
% Na	NA		86	88	NA	
Sr (ug/l)	NA		4211	2600	NA	
Bicarbonate (mg/l)	951. 6		606		NA	
Carbonate (mg/l)	168		0		NA	
Sulfate (mg/l)	550		1241	470	NA	
Sulphide (mg/l)	NA		9		NA	
Flouride (mg/l)	1.64		0.6	1.3	NA	
Bromide (mg/l)	NA				NA	
CO2 (mg/l)	NA		7.0		NA	
COD (mg/l)	NA			51	NA	
SOC (mg/l)	NA				NA	
TOC (mg/l)	NA		7.9		NA	
TIC (mg/l)	NA		156		NA	
DOC (mg/l)	NA			2.9	NA	
Ammonia (mg/l)	1.9		1.9	5	NA	
Nitrite (mg/l)	0.03		0.01	.02	NA	
Nitrate (mg/l)	0.02		0.01		NA	
Kjeldahl N (mg/l)	NA		2.1		NA	
Orthophosphate (mg/l)	NA		0.7	.01	NA	

Parameters	BN 10 Jan 1984 mine	BN 1994 mine	Unita Frm Mean P2U Well 1975- 1976	Unita Frm Mean P2U Well 1984	Unita Frm 1994	Unita Frm 16' BH cross with Decline "A" 1994
Total Phosphorus (mg/l)	NA		0.03	.01	NA	
Boron (ug/l)	4700	4100	410	1360	NA	950
Cu (ug/l)	20	<20	2.0	3	NA	20
Fe (ug/l)	130	<20	112	420	NA	26
Mn (ug/l)	40	23	51	250	NA	15
Zn (ug/l)	10	<30	23	5	NA	85

* The flow in the Unita Sandstone at this location was insufficient in Aug. 1994 to obtain a sample or measure the flow.

Current Flows (See Fig. 8): [The following numbers represent the numbers referenced in Fig. 8]

1. The Upper Unita formation (16' Diameter Bore Hole) intercepts with Decline "A" water flow was measured in August 1994 at 0.75 gph.

2. The Unita formation flows water approximately 0.5 gpm.

3. The Birds Nest aquifer flows water in Decline "A" approximately 1.0 gpm.

4. The Birds Nest aquifer flows water in the Shaft approximately 0.5 gpm.

5. The Tuff zone in the lower Green River formation flows an estimated 0.5 barrels of heavy crude paraffinic oil per month.

Closure Method: Let the oil bearing aquifer free flow in the mine and isolate the aquifers (See Fig. 8).

1. Remove the head frame. Removing the headframe is for safety reasons.

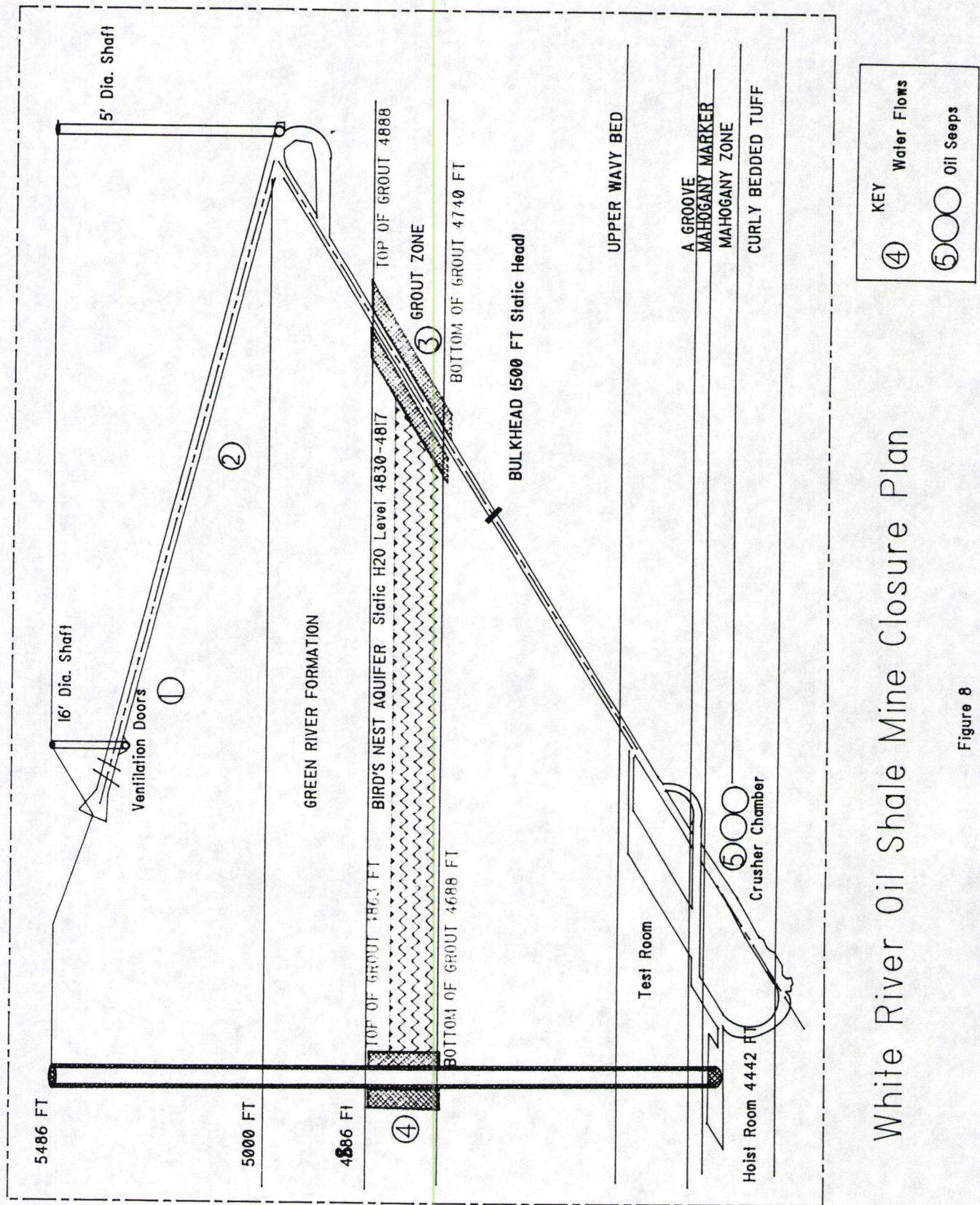
2. Place a bulkhead at the bottom of the Birds Nest aquifer. This bulkhead should be able to withstand 500 feet of static head. This will ensure that no heavy paraffinic crude oil products originating in the sumps will invade the Birds Nest aquifer at Decline "C". The shaft alone will be sufficient double protection in the Birds Nest aquifer because of the 20 inches of concrete lining and the grout zone that currently exists. (See Fig. 9)

3. Seal the 5' diameter ventilation shaft. (See Fig. 10)

4. Seal the 30' diameter shaft. (See Fig. 11)

5. Seal the 16' diameter shaft. (See Fig. 12)

6. Back fill the portal area. (See Fig. 13)



White River Oil Shale Mine Closure Plan

Figure 8

Recommendation:

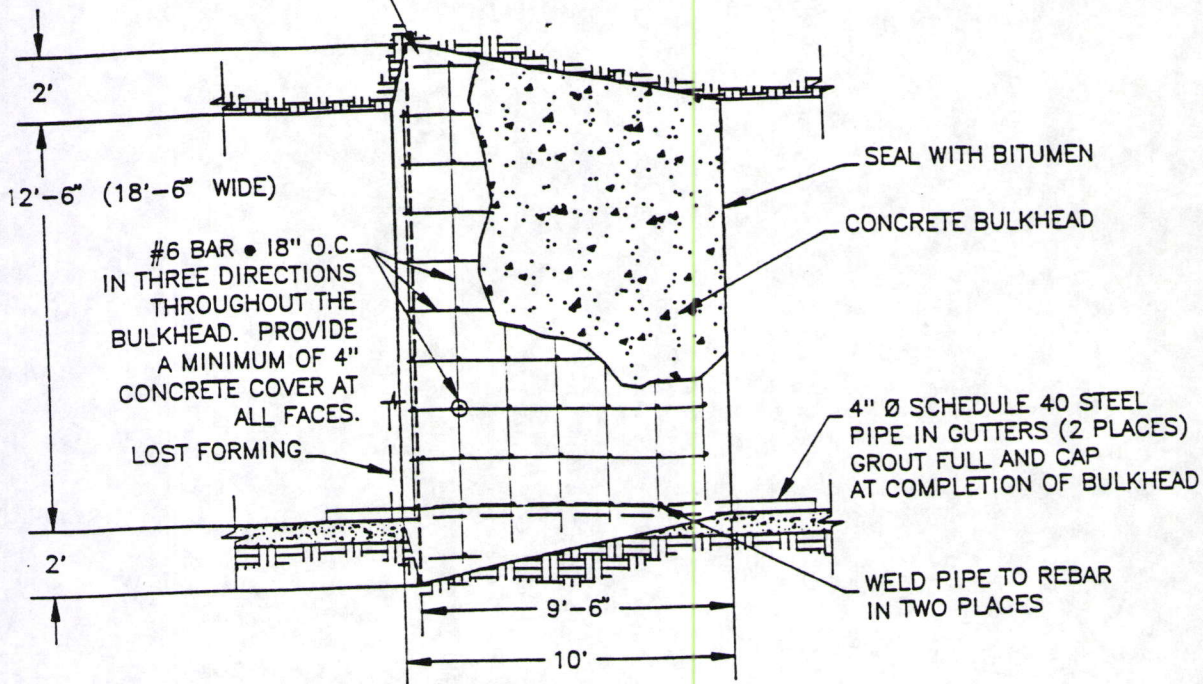
Allow the mine to flood to the bulkhead near the bottom of the Birds Nest aquifer in Decline "A" with fresh water of the Birds Nest aquifer quality. The mine will flood with water and the heavy paraffinic crude products to the top of the Birds Nest aquifer in the 30' diameter shaft. There will be minor contamination in the Green River formation because the oil bearing strata will not be isolated. The Birds Nest aquifer will be adequately protected with a concrete bulkhead from the oily water and the double protection in the decline will come from the grout zone that currently exists in the birds nest zone. There will be double protection from the oil bearing formation from the Tuff zone reaching the Birds Nest aquifer in the shaft with the lining and the grout zone.

Discussion:

This option allows complete protection of the Birds Nest aquifer in the decline "C" and the shaft, but allows the heavy paraffinic crude oil products to flow freely in the flooded mine environment. It is believed the static head from flooding the mine will overcome the static head of the petroleum products seeping from below the Mahogany zone, thus stopping the flow of these products. It will take over 30 years for the oily water to reach the bottom bulkhead of the Birds Nest aquifer in the shaft. This method of closure provides the most protection for the cost invested.

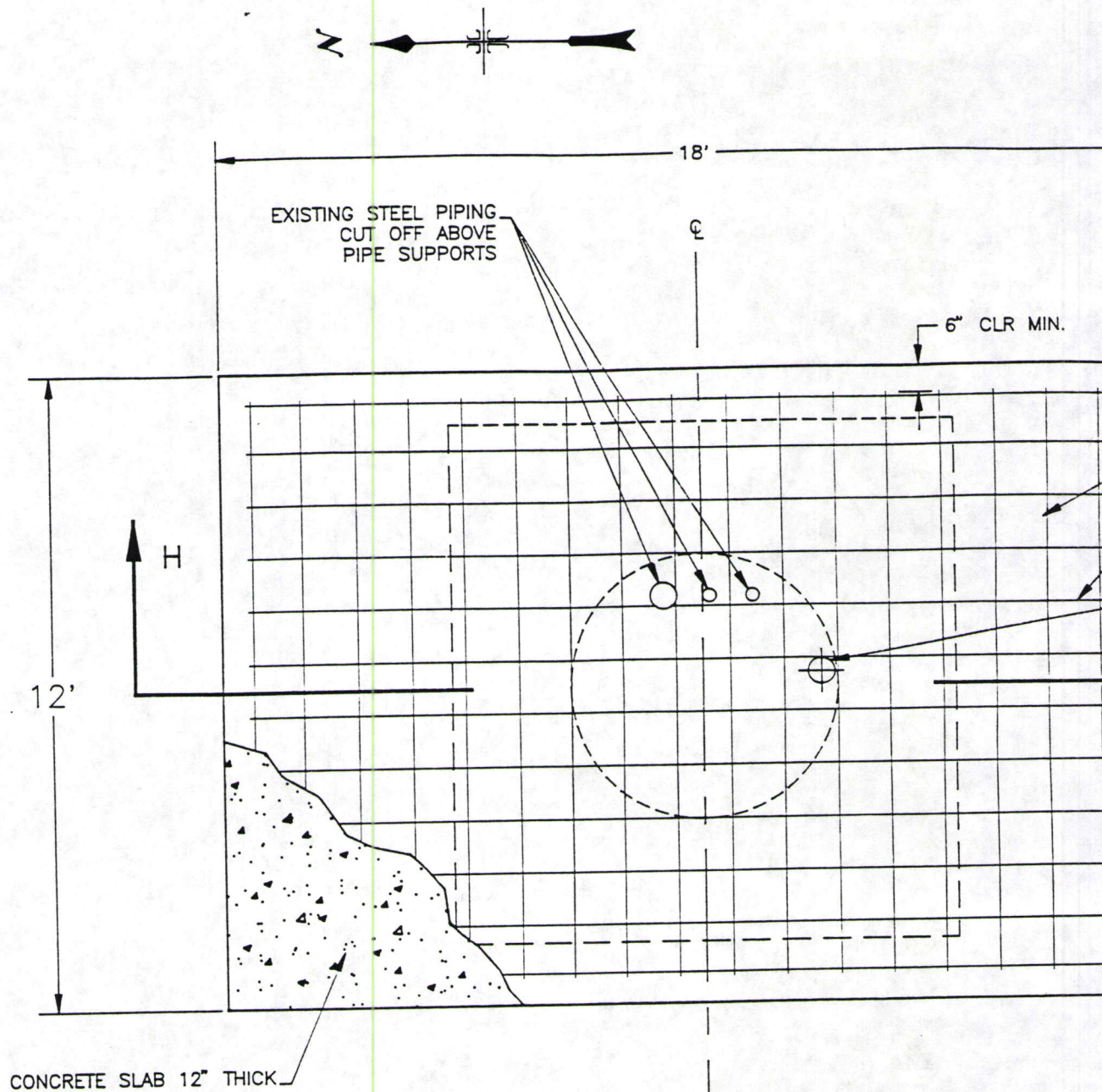
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BULKHEAD KEYWAY TYPICAL
N ROOF, FLOOR AND WALLS.



SIDE VIEW
SCALE 1/4"=1'

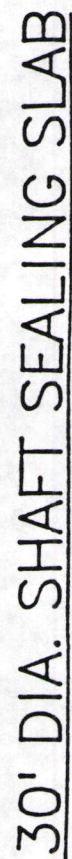
BULKHEAD



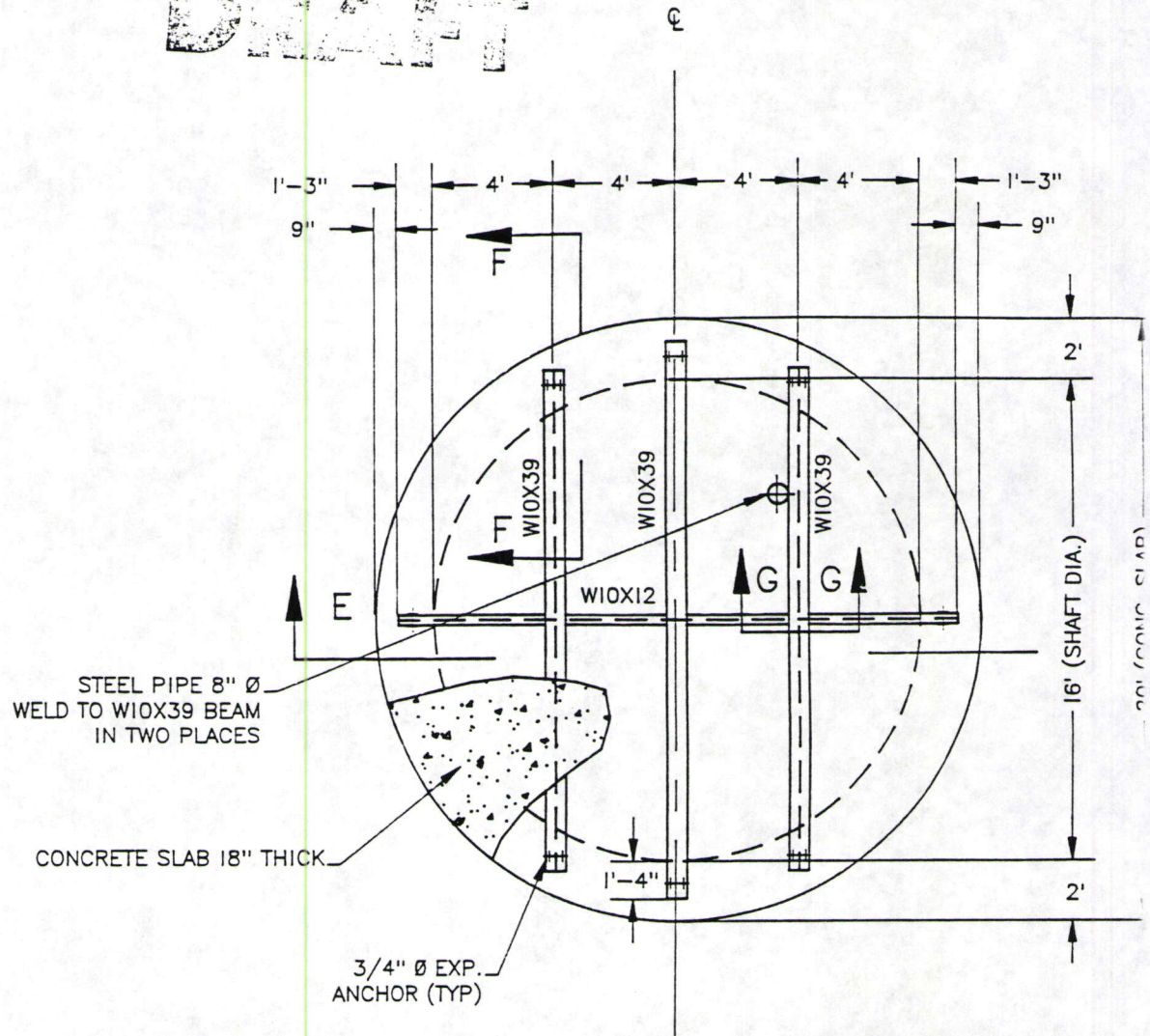
5' DIA SHAFT SEALING SLAB

SCALE 1/2" = 1'

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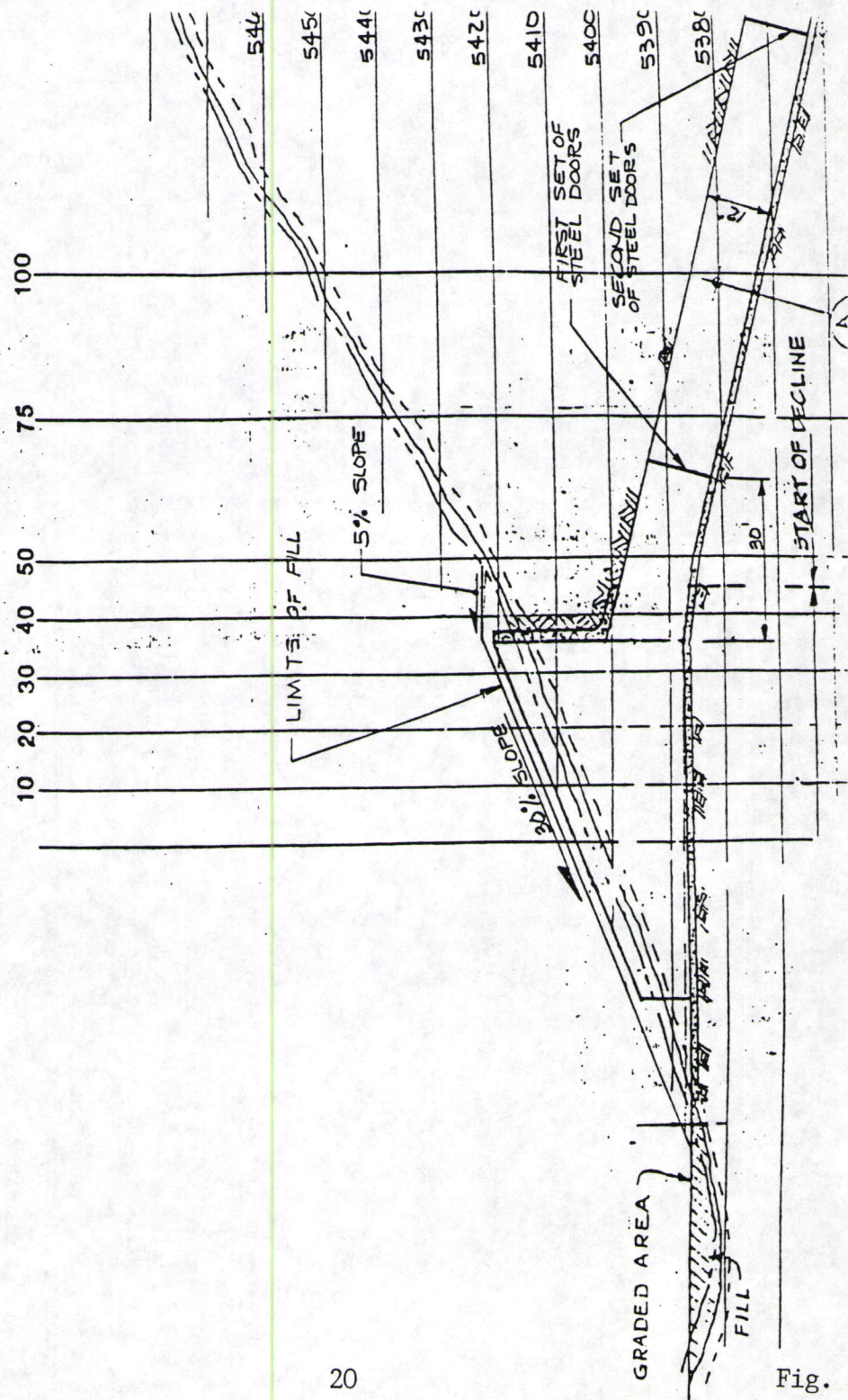
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16' DIA. SHAFT SEALING SLAB

SCALE 1/4"=1'

DRAFT



SECTION AT C OF PORTAL

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